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Heat-Treating Food Waste

Equipment and Methods

September 1983

This publication supersedes "Equipment and Methods for Heat-Treating Garbage for Hog Feed," Program Aid No. 370, issued June 1958. It is intended to serve as a guide to garbage (food waste) treatment facility operators and others on the effective use and care of equipment for heat-treating garbage to be used as hog feed. It is based largely on information obtained by Paul James, the author, during visits to garbage-feeding premises throughout the country.

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Heat-Treating Food Waste:
Equipment and Methods

The use of garbage (food waste) as swine feed presents a problem in animal disease prevention if the garbage is not properly treated. Infected meat scraps in garbage may contain disease-producing agents. When eaten by swine, this infected meat can be the means of introducing and spreading many diseases. In turn, infected swine can spread disease to other livestock and sometimes to people.

Trichinosis is a serious and sometimes fatal parasitic disease of humans contracted by eating raw or undercooked infected pork or meat of wild carnivores. The parasite has persisted in animal populations by one animal eating the infected flesh of another; in swine it has persisted largely through the feeding of uncooked garbage.

Other animal diseases that can be spread by infected meat fed in garbage include, but are not limited to, African swine fever, vesicular exanthema, hog cholera, tuberculosis, swine erysipelas, foot-and-mouth disease, swine vesicular disease, and salmonellosis.

The heat treating of garbage played an important role in the eradication of vesicular exanthema and hog cholera. Both eradication programs employed the following essential measures for disease eradication:

1. Inspection and diagnosis.
2. Prompt disposal of infected and exposed swine.
3. Cleaning and disinfection of infected premises.
4. Control over the marketing of swine.
5. Heat treatment of garbage prior to use as swine feed.

At the urging of the swine industry, the U.S. Congress in 1980 enacted the "Swine Health Protection Act," P.L. 96-468, to regulate the feeding of garbage to swine. The law prohibits the feeding of garbage to swine unless it is treated at a licensed facility that is so constructed that swine do not have access to untreated garbage or to material coming in contact with untreated garbage.

Benefits of Heat Treatment

Heat treatment of garbage is a significant economic factor in disease eradication. Direct costs of the hog cholera eradication program were in excess of $50 million, but the program could not have been successful without garbage cooking requirements. African swine fever is a current disease threat to the swine industry of the United States. Its spread to Brazil and three Caribbean nations in recent years has been attributed to feeding uncooked garbage. If African swine fever should gain entry into the United States and become established, direct costs of eradication are estimated to be from $151 to $558 million.

In addition to preventing the introduction of diseases and the subsequent costs of eradication programs, heat-treating garbage also affects export sales of pork and other agricultural products. If African swine fever should be introduced into and become established in a major swine production area of the United States, it is estimated that eradication would take at least 5 years. The loss of the export market for such items as pork liver, offal, and lard during this period would amount to a minimum of $30 million annually.

Export markets for other agricultural products would also be affected. For example, certain countries which buy our grain require certification of freedom from certain livestock diseases in order to prevent introduction of disease through indirect contamination of the grain.

Although the primary purpose of heat-treating garbage is the control or eradication of swine diseases, many other benefits are derived from the heat treatment. Among these are the following:

1. Hogs will eat more heat-treated garbage than raw garbage. Such items as potatoes, onions, turnips, and citrus rinds —unpalatable when raw—are readily eaten when properly heat treated. Also, research has shown that garbage that is heat treated properly is as nutritious as raw garbage, if it is cooled quickly and if the vitamin-containing juices are conserved. This is a reason for feeding in troughs that retain the liquid.

2. Reports indicate that feeding heat-treated garbage may require less labor than feeding raw garbage because less cleaning is required after feeding.

3. Heating distributes the food value throughout the garbage and thus produces a more uniform feed. This results in faster gains and more pork per ton of garbage. Small pigs cannot be crowded away from the more nutritious parts of the garbage, as may happen when raw garbage is fed.

4. If the initial feeding of heat-treated garbage is carefully regulated through gradual introduction and adaptation, feeder pigs can be "started" at 40 pounds.

5. There is less residue after feeding heat-treated garbage; hence less decomposition. As a result, heat-treated garbage attracts fewer flies than raw garbage and has a less objectionable odor.

Equipment

Many types of garbage-heating equipment have been designed since the outbreak of vesicular exanthema in 1952. Some of this equipment is excellent, some is good, and some is wholly impractical. Two basic types of treatment equipment have proved successful: (1) direct-fire equipment (for small-scale operations) and (2) steam-injection equipment (for large-scale operations).

Direct-fire Equipment

Direct-fire equipment is used chiefly for loads under 300 gallons. Direct-fire equipment is usually constructed on the farm and generally consists of an open-top cylindrical vat enclosed in a firebox (fig. 1). The garbage is heated by flames in direct contact with the vat.

Figure 1. — Direct-fire equipment

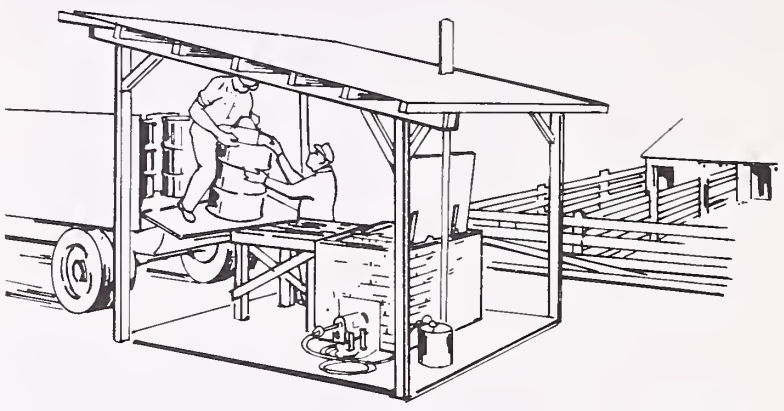
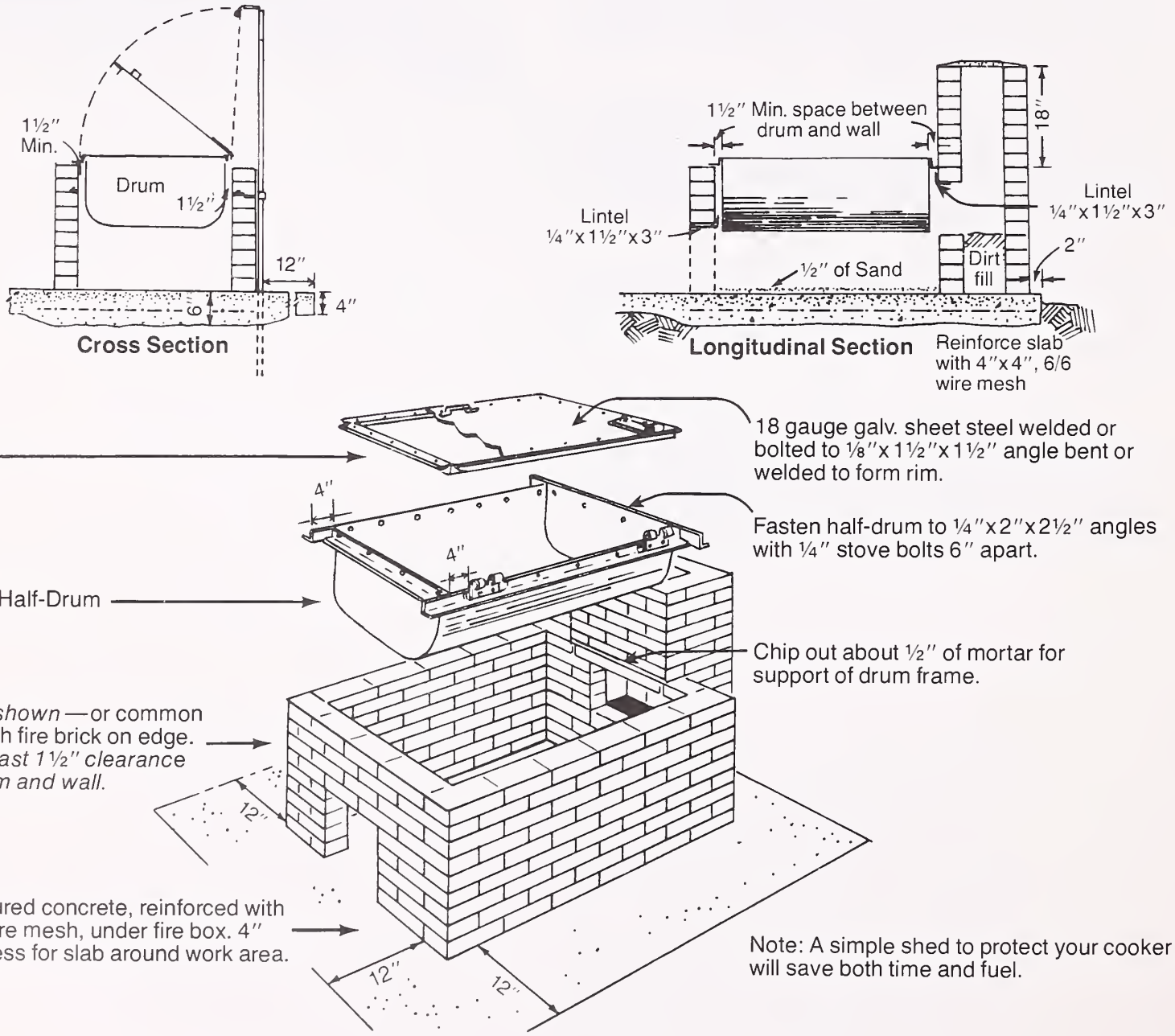


Figure 2. —Plans for efficient direct-fire equipment



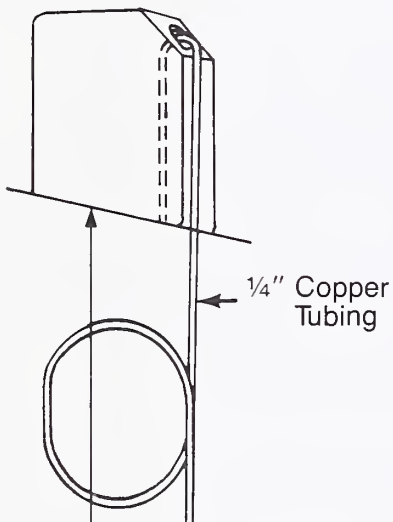
Although wood is frequently used as fuel, kerosene or fuel oil is less bother and cleaner. Gasoline should not be used; it is too explosive to use in a confined firebox. The design for a gravity-feed oil burner is provided in figure 3.

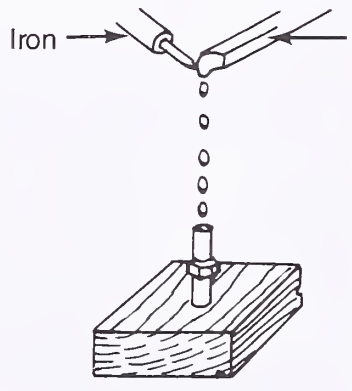
If wood is used, the ashes should be removed daily (fig. 4). Garbage in the bottom center of the load will not heat properly if there is an accumulation of ashes in the firebox.

If a large opening is desired for placing the wood beneath the vat, some means must be provided to reduce the size of the opening after fueling. This is necessary to prevent flames and smoke from escaping. The size of the fuel opening should be reduced to be equal to or less than that of the chimney.

Figure 3. —Gravity-feed oil burner

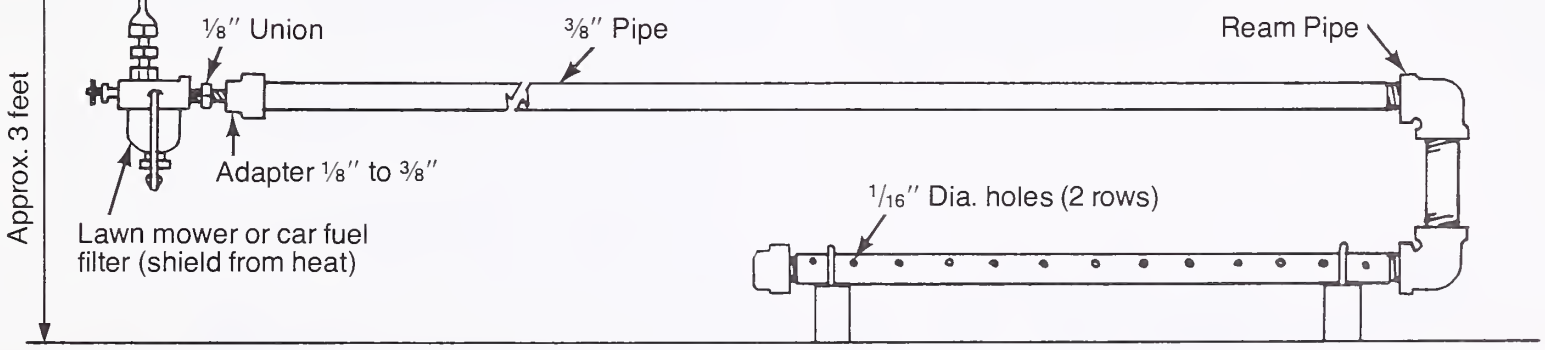
Warning:
Do not use gasoline —the burner will not operate with gasoline. It is too explosive to use in a confined fire box.





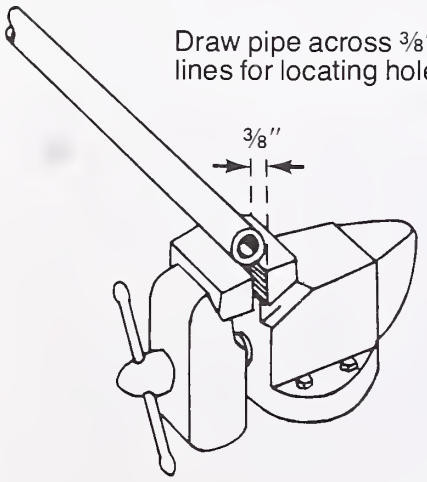
Place fitting on wood block. Drop solder in it and then drill 1/32" hole through center. (can drill hole with cut-off paper clip.)

Note: The 1/32" diameter hole in the fitting feeds 30 1/16" diameter holes at the rate of 1½ gallons per hour. These hole sizes must be maintained.

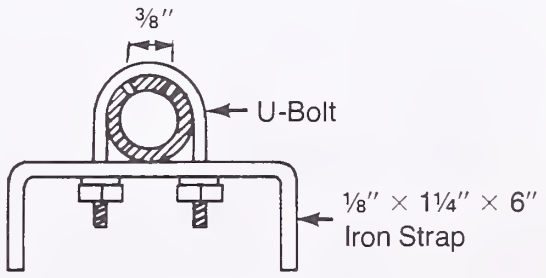


Burner

Note —If holes in burner pipe fill with soot, clean out by dipping hot pipe in water.

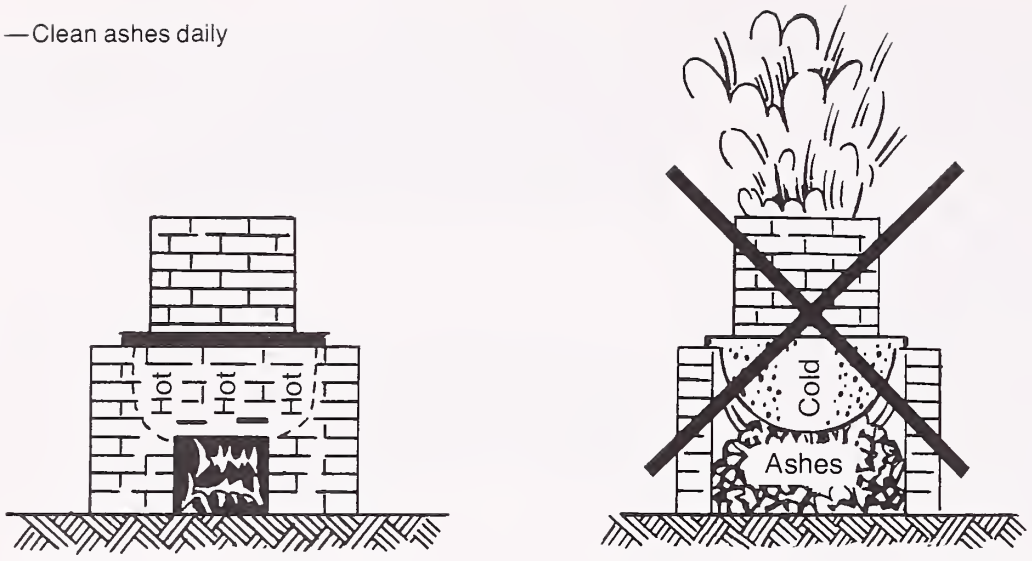


Draw pipe across ⅜" opening of vise to score lines for locating holes.



Cross Section
Angle of 1/16" holes in pipe, stagger in two rows.

Figure 4. —Clean ashes daily

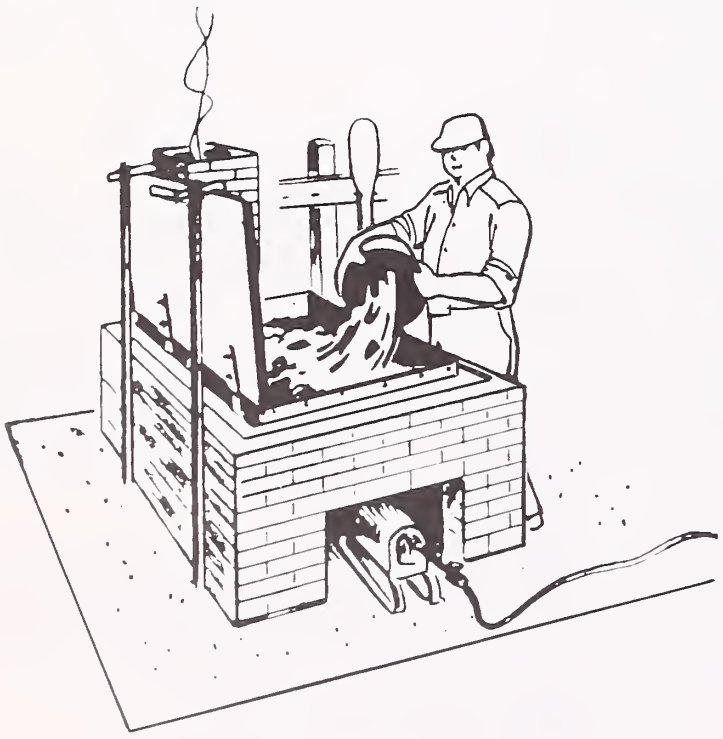


With direct-fire equipment, water evaporates during the heating period. If all the water evaporates and the garbage becomes dry, the vat will overheat, and garbage will stick to the bottom of the vat and may burn.This will ruin the feed and may also ruin the vat. Because water is a better conductor of heat than air, garbage surrounded by water heats more rapidly than dry garbage (fig. 5). Water must be added to cover most of the garbage or, if the garbage floats, the vat should be filled only about one-third full of water.

Steam-injection Equipment

Steam-injection equipment, which heats the garbage by injecting steam into the bottom of the load, is recommended for loads greater than 300 gallons (fig. 6). It is easier to distribute heat evenly over the bottom of a large container by steam-injection heat than by direct-fire heat. In addition to the need of being distributed over the entire bottom of the load, the steam must be injected in such a way that it can bubble up through the entire depth of the garbage.

Figure 5. —Add water to dry garbage



Many users of steam-injection equipment treat the garbage in the same trucks in which the garbage was collected. Regardless of whether heating is done in trucks or stationary vats of different sizes, the same basic principles apply.

Steam-heating pipes must be placed on the bottom of the truck body or vat (fig. 7A). If the pipes are placed as little as 2 inches above the bottom, a cold area between the pipes and the bottom will result.

In a flat-bottom vat, one pipe must be placed from each corner as close to the side as possible (fig. 7B). In a round-bottom vat, one pipe must be placed on the bottom. The pipes should be no farther than 14 inches apart and preferably not more than 12 inches. A No. 6 scoop shovel can be used between pipes 12 inches apart on center.

The heating pipes should be welded to the vat or truck body only where they go through it to the blowoff valves. To allow for pipe expansion, there should be at least a half-inch clearance between the end of the vat or truck and the header, which is the main source pipe inside the vat (fig. 7C).

The laterals, which are the pipes with holes that distribute heat by injecting steam into the load, should be connected to the header by a union (fig. 7D). This permits proper placing of the injector holes and eases replacement of the pipes.

The pipes should extend through the bottom or end of the truck, and hand valves for blowing out the pipes should be placed on the ends (fig. 7E). This permits steam to reach the end of each pipe and heat all parts of the load.

Figure 6. —A steam-injection system

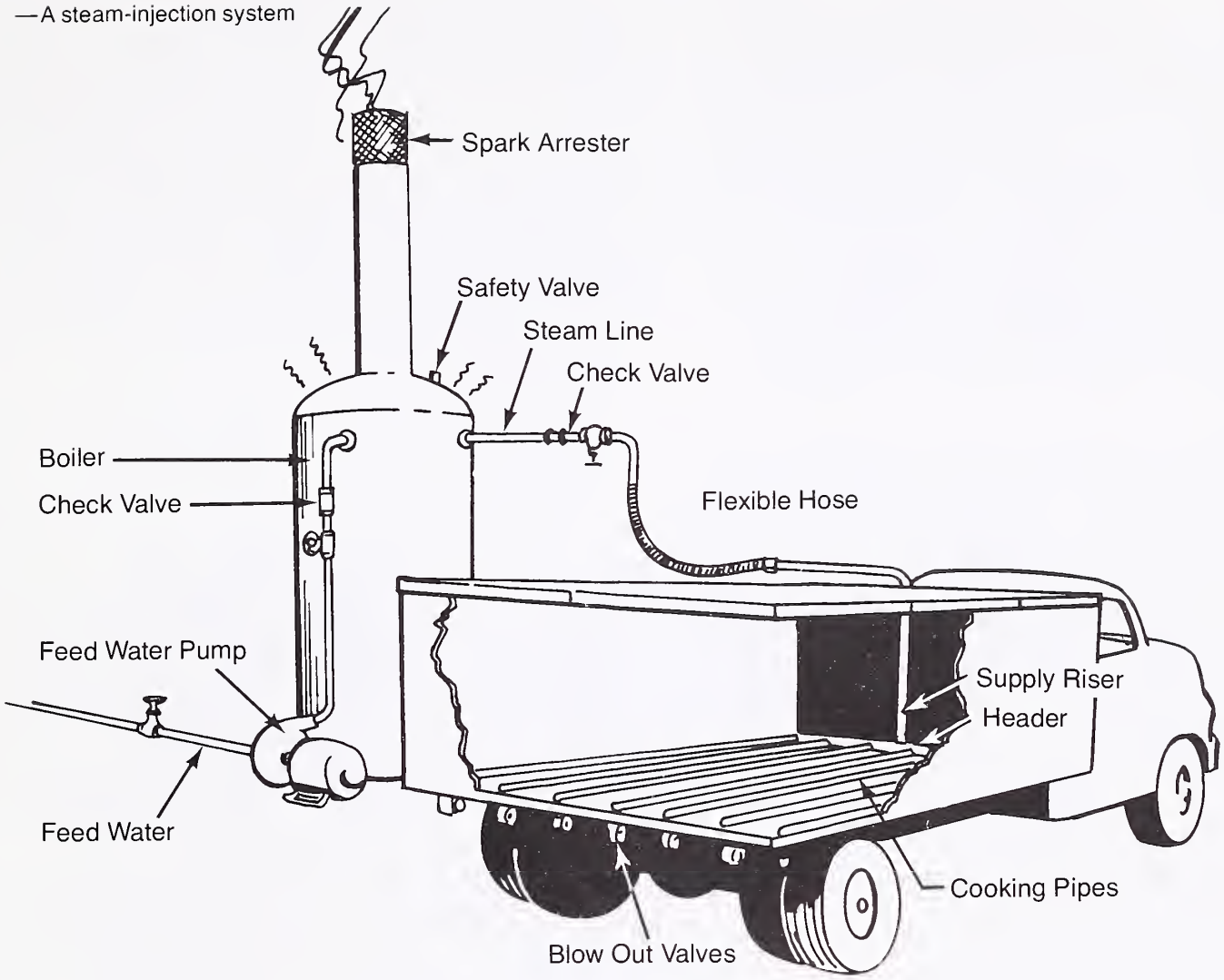
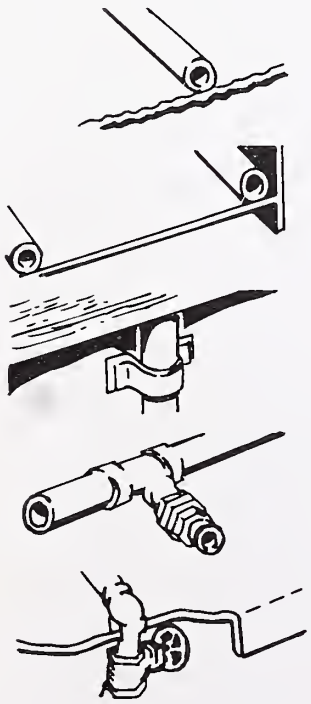


Figure 7. —Steam pipes in trucks



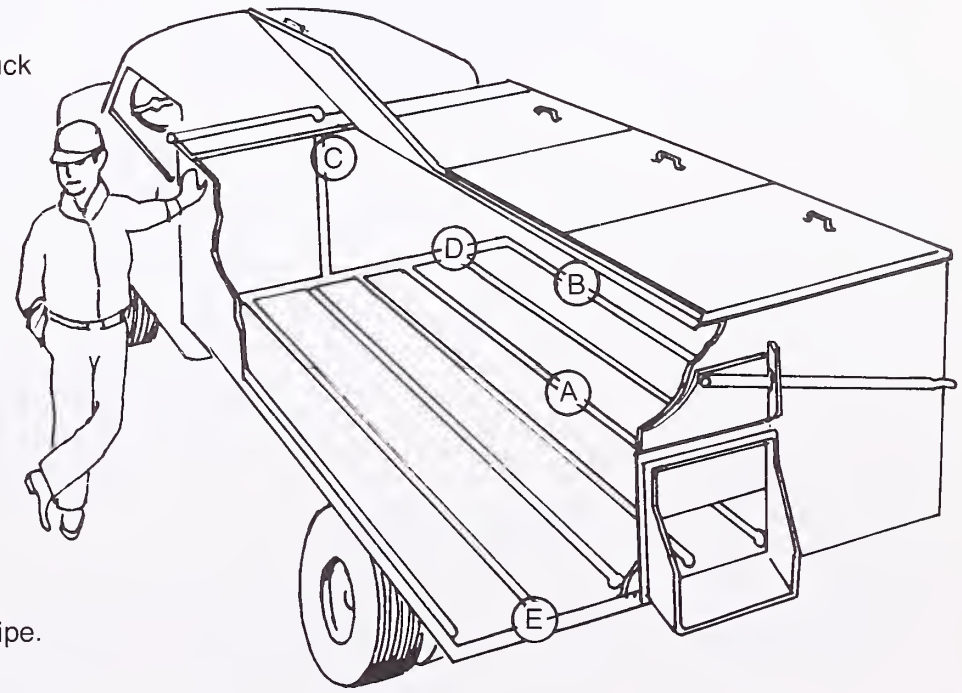
A Pipes on the bottom of truck or vat.

B Pipe in corner.

C Clamp at top or riser.

D Union along header.

E Blow off valve at end of pipe.

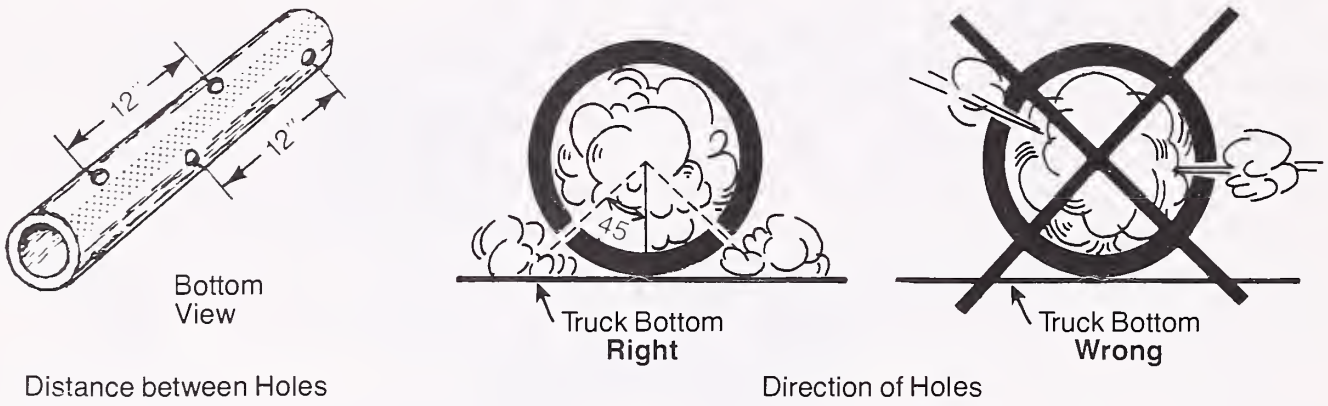


Holes in the laterals must be as small as practical for proper distribution of pressure in the entire length of pipe. Holes one-sixteenth inch in diameter are desirable. The holes should be at 12-inch invervals in each of 2 rows. Each row should be drilled at a 45-degree angle to the bottom of the vat, as shown in figure 8. This angle will direct the steam against the bottom of the vat or truck for complete coverage and maximum penetration.

One of the most important differences between the direct-fire and steam-injection methods of heating is that the former removes water from the garbage whereas the latter adds water. As the steam cools it changes into water, which remains in the load.

While a boiler is running continuously with a steady pressure, it is adding water from the condensed steam at a rate of approximately 4.2 gallons per hour for each horsepower of the boiler. For example, during the first hour a 30-horsepower boiler operating continuously will add about 125 gallons of water. If the boiler operates only one-fourth of the time during the second hour, it will add ¼ of 125, or about 31 gallons. If the boiler is old or a type that produces a lot of water in the steam, this amount may be doubled.

Figure 8. —Location of holes in pipes



Distance between Holes

Direction of Holes

Good heating methods, as well as good equipment, are important. Good methods help to attain even temperatures throughout the load, make the feed more palatable, and increase the life of the equipment.

Select the Vat With Care

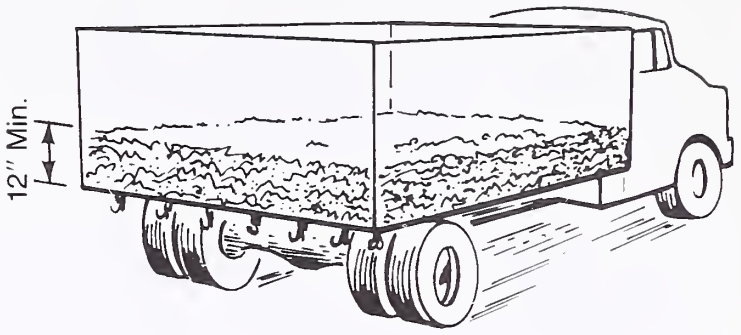
Select a vat of the proper size. Use of a large vat for a small amount of garbage wastes heat. The vat should be almost filled with garbage during each heating. For larger than normal loads, it is advisable to heat twice in a small vat or to use spare equipment.

With steam-injection equipment, the depth of garbage in the vat or truck should never be less than 12 inches (fig. 9). Steam passes too readily through shallow layers and is especially objectionable if the injector holes are oversized (larger than one-sixteenth inch).

Round-bottom vats, in particular, do not heat properly with either direct-fire or steam-injection equipment when they are underloaded. When steam-injection equipment is used in round-bottom vats difficulty may be encountered in unloading since one injector pipe must be placed in the bottom of the vat.

For these reasons, flat-bottom vats are preferable; however, they are more inclined to warp and they may be more difficult to obtain.

Figure 9. —Garbage must be at least 12″ deep



The capacity of vats of various dimensions is given in tables 1 and 2.When determining the size of container to obtain, allow for the water that will be added to the garbage (before heating is begun when direct-fire heating is used, during the heating period when the steam-injection method is used). If the vat is mounted on a truck or trailer chassis, be sure to keep the weight under the legal load limit per axle. The average weight of a cubic yard of garbage is 1650 pounds.

Table 1. Round Vat Capacity

Radius in inches	Capacity per foot of length (volume) Cubic yards	Gallons	Radius in inches	Capacity per foot of length (volume) Cubic yards	Gallons
18	0.13	27	27	.30	59
19	.14	30	28	.32	64
20	.16	33	29	.34	69
21	.18	36	30	.36	74
22	.20	39	31	.39	79
23	.22	43	32	.41	84
24	.24	47	33	.44	89
25	.26	51	34	.47	94
26	.28	55	35	.50	100

To find the capacity (volume)

Step 1. Measure the radius in inches. Locate this under *radius* column. Choose either *cubic yards* or *gallons* and record this _____(a)

Step 2. Measure the length in inches _____(b).

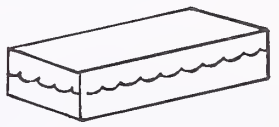
Step 3. Insert recorded figures from above for either cubic yards or gallons: $\frac{(a)}{1} \times \frac{(b)}{12} = \frac{}{\text{Total}}$

Table 2. Rectangular Vat Capacity

Width (in feet)	Length (in feet) 8	7½	7	6½	6	5½	5	4½	4	3½	3	2½	2
	Gallons per 1 foot depth												
2	120	112	105	97	90	82	75	67	60	52	45	37	30
2½	150	140	131	122	112	103	94	84	75	65	56	47	
3	180	168	157	146	135	123	112	101	90	79	67		
3½	209	196	183	170	157	149	131	118	105	92			
4	239	224	209	194	**180**	165	150	135	120				
4½	269	252	236	219	202	185	168	151					
5	299	281	262	243	224	206	187						
5½	329	309	288	267	247	226							
6	359	337	314	292	269								
6½	389	365	340	316									
7	419	393	367										
7½	449	421											
8	479												

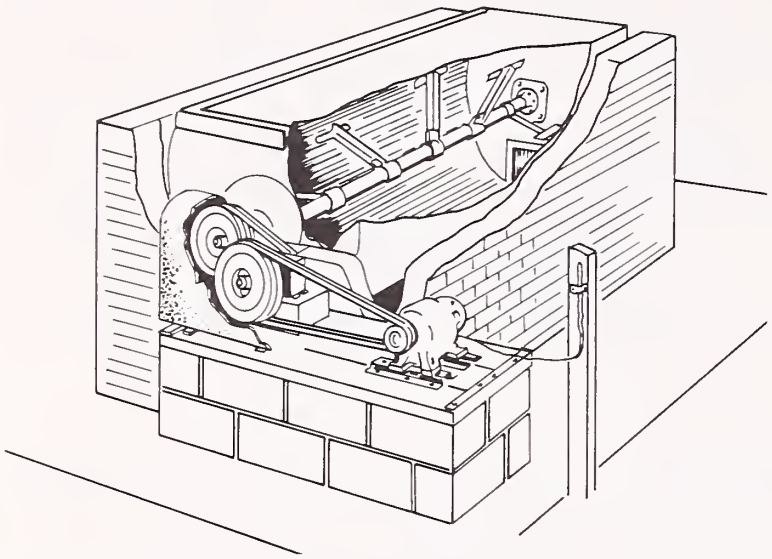
Note: One cubic yard equals approximately 200 gallons.

Example: a 4-foot-wide vat with a length of 6 feet would hold 180 gallons at 1 foot depth. If actual depth is 2½ feet: 2½ × 180 = 450 total gallons.



Step 1. Choose the length and width which corresponds closest to your vat.
Step 2. Select the appropriate number of gallons from the table.
Step 3. To find the capacity at a depth other than 1 foot: multiply the number of gallons by the depth in feet. See example in table.

Figure 10.—Mechanical agitator



Stir the Garbage

Stir the garbage to help distribute the heat throughout the load. Stirring reduces the size of the cold regions and destroys steam channels that sometimes form in the load. These channels are objectionable because the steam escapes without losing heat to the garbage. Stirring also helps to keep garbage from sticking to the bottom of the vat.

Because garbage is easier to stir when it is hot than when it is cold and because most of the benefits of stirring occur after some of the garbage is heated, many feeders do not stir during the first 30 minutes of the heating period.

Use of a mechanical agitator with direct-fire equipment (fig. 10) eliminates much of the labor of stirring.

Keep the Load Covered

Keep the load covered during heating, except when stirring. A properly covered load of garbage heats almost as rapidly at the top as at the bottom because the cover holds the steam against the garbage at the top. Since more of the heat goes into the garbage in a covered load rather than being lost to the surrounding air, the heating period is shortened and a savings in fuel and labor results.

It is especially important to keep trucks and large vats covered during heating. The savings in fuel, because of the shortened heating period, is correspondingly greater.

Metal covers are preferable. The underside of wooden covers should be lined with sheet metal.

Hot cooking greases quickly ruin rubber gaskets; therefore, gaskets should be made of canvas belting, neoprene, old sections of fire hose, or similar material. An angle iron should be fastened around the inside edge under the cover to keep the juices from running out from under the cover and down the sides of the vat or truck (fig. 11)

Steam escapes around the edges of the cover. Therefore, the cover should be as small as is practical for loading and unloading, and it should fit tightly at the sides. Also, the cover should have few open joints and should fit down closely over the garbage. Heavy, curved covers that extend some distance beyond the vat waste heat.

Covers for large equipment may be difficult to handle. Covers for trucks or large vats have been made from sheet metal in several light sections (usually 4 by 8 feet). The sections are flanged and slide together. Other feeders use a one-piece cover with hoist (fig. 12).

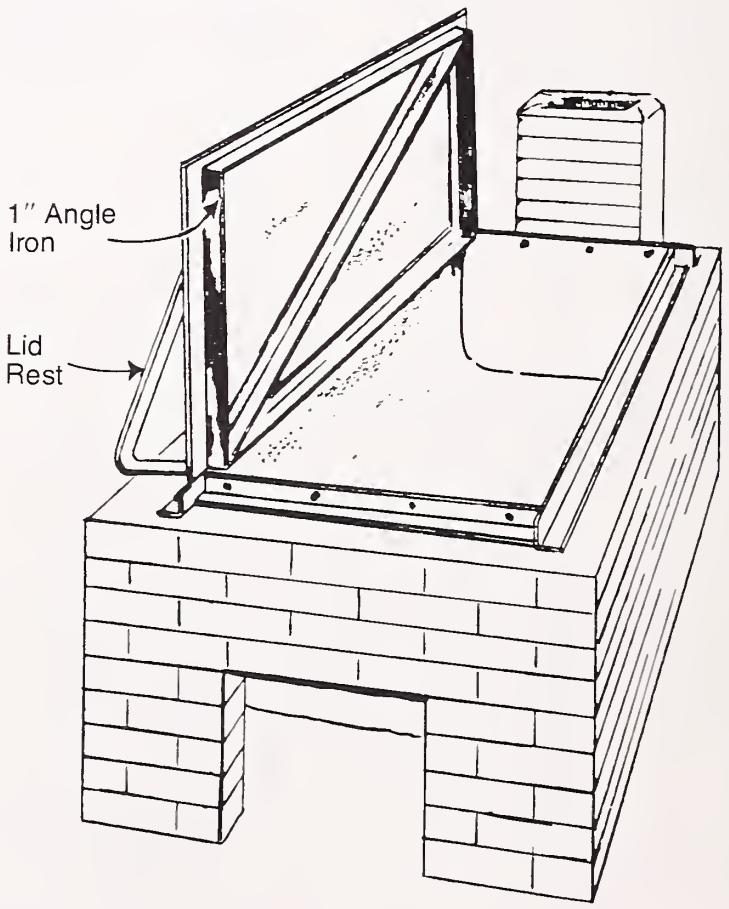
Tarpaulins are not suitable covers if steam escapes through them.

Keep the Load Level

Uneven loads of garbage heat unevenly (fig. 13). The vat should be kept level, whether it is on wheels as on a truck or permanently situated.

With direct-fire equipment, the garbage at the shallow end of the vat may char before that at the deeper end has boiled. If a truck is backed up to the vat, a wheel stop should be built in the ground to prevent the truck from accidentally knocking the vat over or off balance.

Figure 11.—Angle-iron drip catch



With steam-injection equipment, it is also important to keep the load the same depth throughout to obtain even distribution of heat. Steam will escape unused from shallow garbage. A correspondingly longer heating period will be required to heat the garbage in the deeper section of the vat.

Apply Heat to the Sides of the Vat
The more heating surface the garbage is in contact with, the shorter the heating period. Therefore, all sides of the vat should be heated.

With direct-fire equipment, a space of at least 1½ inches should be provided on all sides of the vat for the heat. This space should extend to the top of the garbage level. The vat should be hung on angle irons attached at the top. If the vat is supported from beneath, the support will overheat and sag.

With steam-injection equipment, injector pipes should be placed on the bottom as close to the sides as possible (fig. 14).

Keep the Equipment Clean
Equipment should be kept clean for efficient operation. A regular time should be established for cleaning, preferably after each heating period. Any garbage that sticks to the bottom of a vat heated by direct-fire equipment should be cleaned immediately while the vat is still hot. It will be much easier to remove at that time than later when grease in the garbage has cooled. If accumulated garbage is not removed from the interior surfaces of the vat, it will eventually char. Charred garbage acts as insulation and increases the length of the heating period required. In addition, the vat will corrode under the charred section.

When steam-injection equipment is used, foreign objects such as bottle caps should be flushed away from the steam outlets to prevent their being blocked.

Equipment should also be kept clean to make it safe. Hot greasy covers are difficult to handle and often result in burns. Garbage spilled around the equipment makes walking a hazard.

In addition to keeping the equipment efficient and safe, cleanliness helps to prevent disease by controlling flies and rats. These disease carriers will not stay where they cannot obtain food.

Keep the Equipment Under Shelter
Protect the equipment from stormy weather. A cold wind blowing against the sides of heating equipment makes the windward side hard to heat. If it is raining or snowing on the equipment, heating is difficult. A roof over the equipment to keep out rain and snow is probably a sound investment. It need not be elaborate; in mild climates a simple pole structure is adequate. The roof also provides shelter for the operator and keeps fuel dry.

Figure 12.—One-piece lid with hoist

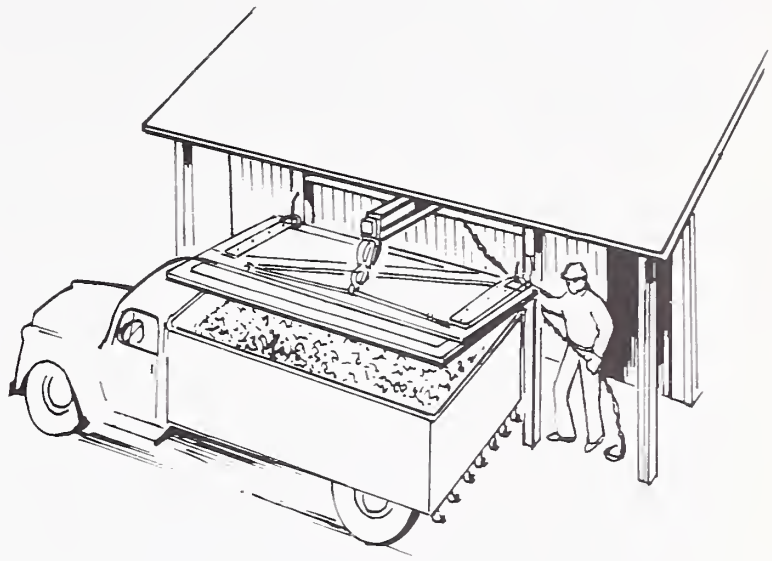
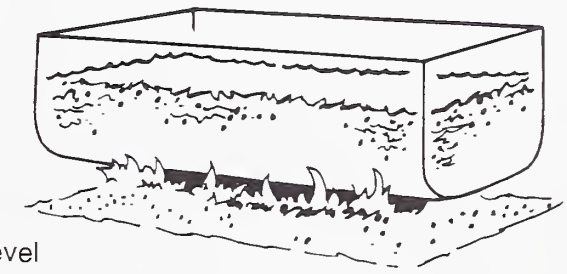


Figure 13.—Keep the load level



Keep level

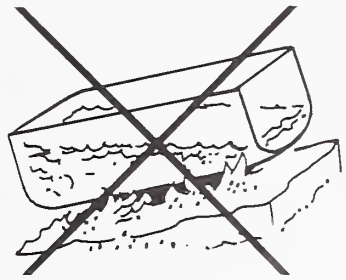
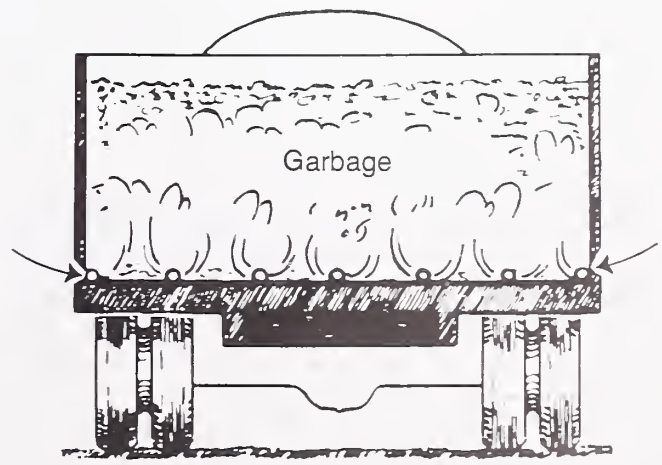


Figure 14.—Place steam pipes on the bottom of the vat and as close to the sides as possible



Special Instructions for Heating Garbage by Steam Injection

Many people who heat garbage by the steam-injection method, even those with good equipment, do not always use their equipment to best advantage. Good heating methods keep the time required to heat-treat garbage to a minimum and prolong the life of the equipment. The following methods have been found effective:

Step 1—Check the Water Supply

Check to see that there is water in the boiler and that the water-supply system is operative (fig. 15). Enough water should be on hand to supply the boiler during the entire heating period (4.2 gallons per horsepower for each hour of cooking).

Step 2—Blow Out the Scale

Flames are actually carried in the boiler tubes to heat the water in the boiler. The heat from the flames must then pass through the walls of the tubing to reach the water in the boiler. Both soot on the inside (flame side) of the tubing and mineral deposits, called scale, on the outside (water side) of the tubing act as insulation and lessen this transfer of heat. These foreign deposits prevent heat transfer in the boiler, with resultant slow heating.

Soot may be removed from within the flame-carrying tubes by cleaning with a stiff wire brush, which usually is supplied by the manufacturer. Addition of chemicals to the water will remove scale and retard its formation. The cost of the chemicals is nominal. Consult your local boiler supplier regarding the chemicals to use in your locality.

After the boiler has reached operating pressure, anchor the flexible outlet hose securely at the open end. Make sure no one is standing near the open end, gradually open the steam valve wide for 5 seconds to blow the scale from the boiler (fig. 16). This helps to prevent scale from collecting in the boiler. In terms of time and shutdown period required, removal of scale from the boiler is probably the most expensive single maintenance operation.

Step 3—Inspect the Injector Pipes

Inspect the flexible hose and coupling to injector pipes and replace any worn hose. Use only high-pressure hose designed for steam. The innerlining of other hose will scale out, collect in the injector pipes and close the holes (fig. 17). The expense of new hose is minor compared with the cost of an accident. Connect the hose securely to the injector grid.

Step 4—Turn Steam Into the Load

Gradually open the steam valve to turn steam into the load. It is normal for the boiler pressure to drop when the valve is first opened because the cold garbage absorbs steam rapidly (fig. 18).

Figure 15.—Check the water supply

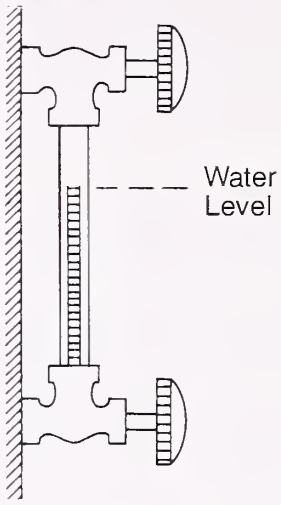


Figure 16.—Blow out the boiler scale

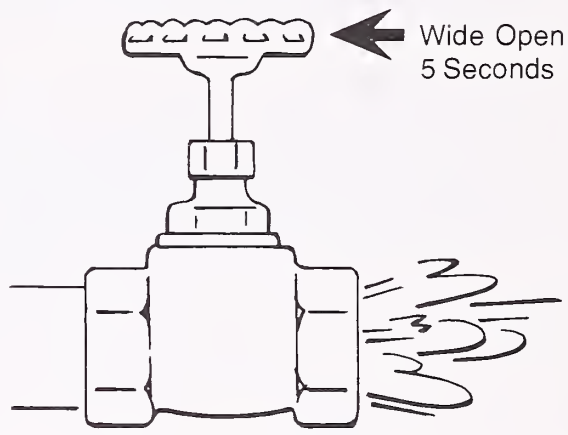
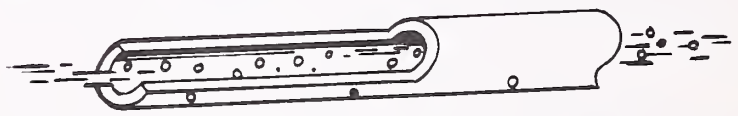
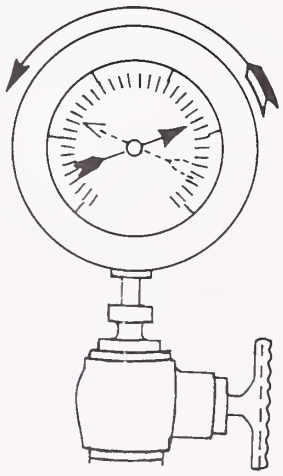


Figure 17.—Inspect the injector pipes



Lining particles from rubber hose plug injector holes

Figure 18.—Open the steam valve gradually



Drop in pressure is normal when valve is first opened

Figure 19.—Blow out the injector pipes

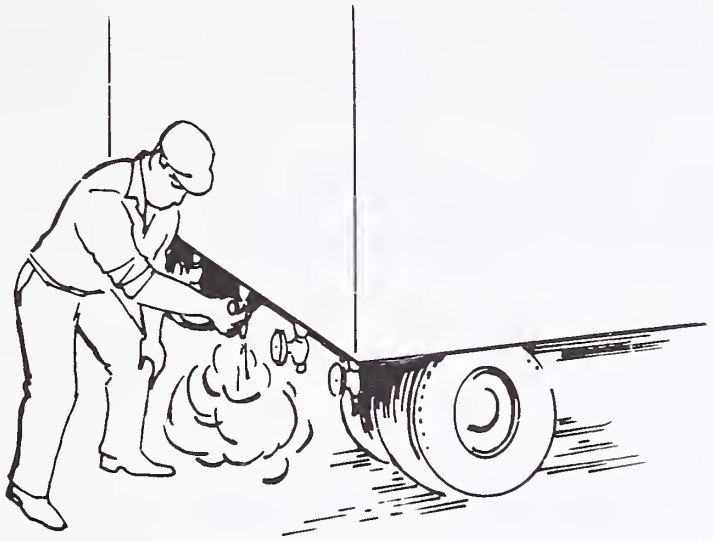


Figure 20.—After half an hour, partly close the valve

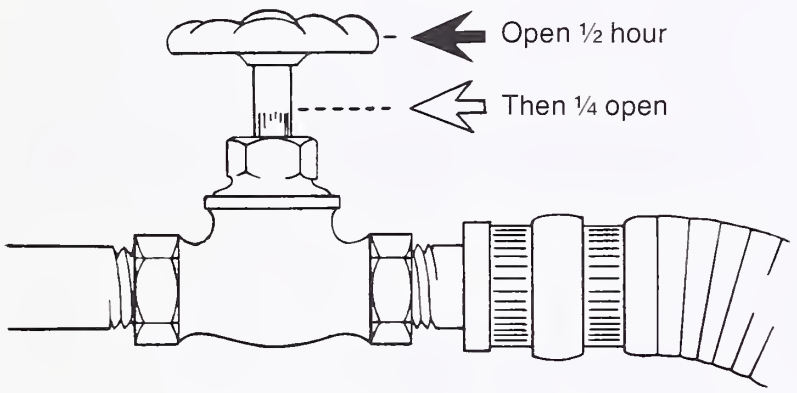
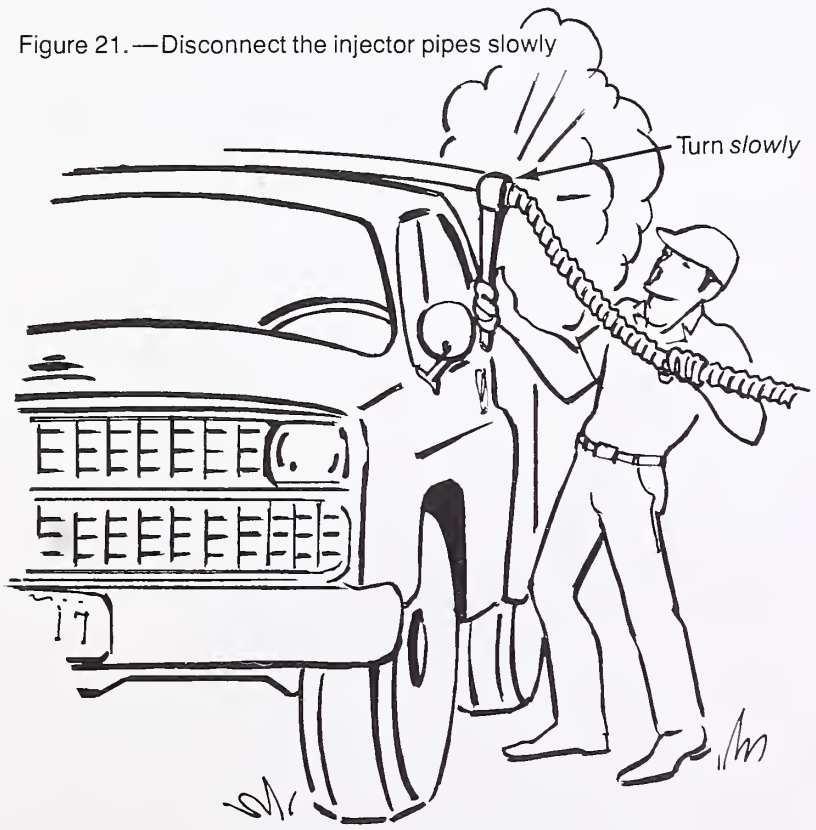


Figure 21.—Disconnect the injector pipes slowly



To be sure that steam rather than hot water is leaving the boiler, keep the pressure above 5 pounds. However, do not put more steam into the load than the garbage will absorb. Escape of an excessive amount of steam from the load indicates that more steam is going into the garbage than is being absorbed.

Step 5—Blow Out the Injector Pipes

After adjusting the boiler pressure, open the blowoff valves on each of the injector pipes grid until only steam escapes (fig. 19). The blowoff valves should be maintained. Failure to clear the pipes results in an accumulation of sludge in the pipes, and eventually the steam is unable to force this sludge out. When the steam inlet valve is closed at the end of the heat treatment, the steam pressure in the injector pipes is reduced. As a result, the garbage fluids and small particulate matter will be drawn by vacuum into the pipes through the injector holes. If the holes are large, coffee grounds may enter the pipes. In one cooker in which the holes were large and the cleanout valves were not used, there was an accumulation of 18 inches of coffee grounds in the pipes. The garbage would not heat beyond this section of the pipes.

Step 6—Partly Close the Valve

Hot garbage does not absorb steam and heat as rapidly as cold garbage, and steam that is not absorbed will escape the load unused. Therefore, between 30 minutes and an hour after turning steam into the load, partly close the valve to reduce the amount of steam that is entering (fig. 20). Often the valve may be closed until the opening is only about one-fourth the initial opening.

Step 7—Turn Off the Steam

After the load has boiled 30 minutes, turn off the steam. This will normally be from 2 to 2½ hours after the beginning of operations. (In cold weather it may be desirable to set the boiler on low pressure rather than to turn it off completely.) Clean grease from the steam lines and valve handles.

Step 8—Disconnect the Injector Pipes

The inlet valve must be closed and injector pipes disconnected while the boiler is still hot because a vacuum is created in the boiler as it cools. This could draw garbage from the injector grid into the boiler through a partly opened valve. Disconnect the coupling to the injector system. Because of the danger of being burned by steam, disconnect it slowly (fig. 21). Cap the open steam line leading into the injector system to keep out dirt.

The amount of steam a boiler produces per hour is one of the important factors to consider in selecting a boiler or generator. The boiler should be large enough to produce enough steam to heat-treat the garbage in a reasonable time.

Steam is measured in terms of weight—that is, ounces or pounds of steam. This has nothing to do with boiler pressure. Boilers that turn 1,000 pounds of water into steam in an hour have the same heat-producing ability whether they are low-pressure or high-pressure boilers. A boiler that turns 1,035 pounds (or about 120 gallons) of water into steam per hour is said to be a 30-horsepower boiler. A general guide is that a boiler should have 8 horsepower for each ton of garbage or 6.5 horsepower for each cubic yard.

It is more economical to size the boiler for a "normal" load than larger loads which are the exception. Consult your local plumber or boiler distributor before purchasing a boiler.

Either low-pressure or high-pressure steam may be used to heat-treat garbage. Many feeders who believe they are heating with high-pressure steam may actually be using low pressure in the injector pipes if the valve between the boiler and injector pipes is partly closed (fig. 22).

A large pressure drop in the injector grid can be tolerated better with high-pressure steam than with low-pressure steam (fig. 23). The pressure drop should be kept to a minimum, regardless of the operating pressure. This is best accomplished by keeping the injector holes small.

Steam ordinarily contains some unvaporized water (small invisible droplets of water). Steam that contains a high percentage of these water droplets is called wet steam. *Wet steam is not good for heating garbage.* Much heat is released as the steam vapor changes back to water. This heat is provided by the process of condensation that changes gas (steam) to liquid (water). If the steam is a mixture of 25 percent steam vapor and 75 percent water droplets, only 25 percent is effective in releasing heat to the garbage. The other 75 percent is only hot water, which is added to the load and releases very little heat.

Care of the Boiler

Periodic checkups will lengthen the life of the boiler and improve its performance. Points to check include the following:

Clean the Burner

The burner should be removed from the boiler and cleaned thoroughly when necessary, which is often monthly. Rust and other material that has dropped on the burner should be loosened with a stiff wire brush; then the loosened material should be shaken out of the burner head and mixer. If the burner shows a delayed action, as indicated by a flashback, each burner port should be reamed out with a twist drill the same size as the original hole. The burner should be cleaned with a wire brush at this time.

Figure 22.—Valve partly closed results in low-pressure steam

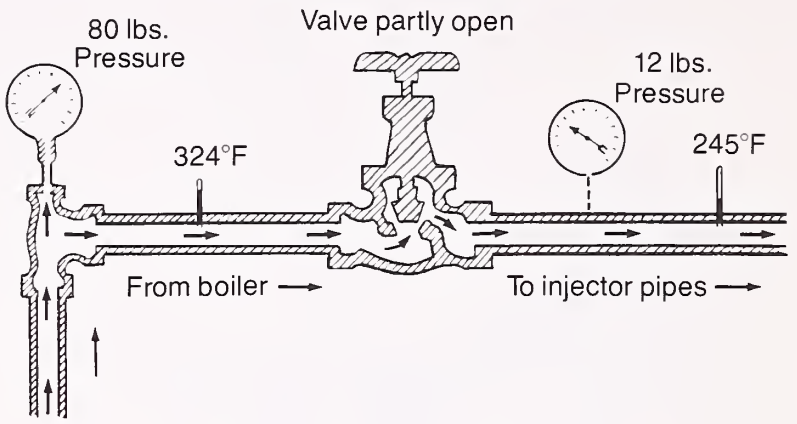
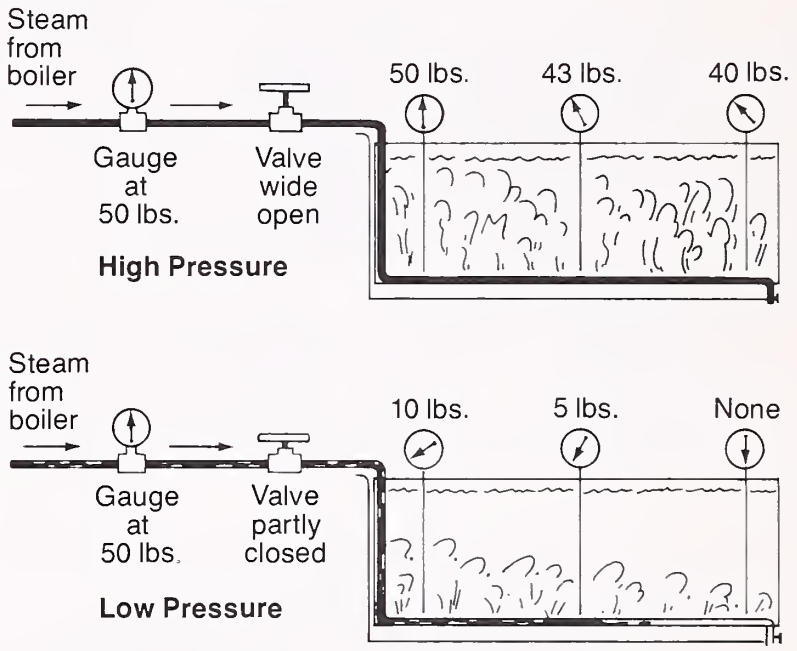


Figure 23.—Effect of pressure drop on high-pressure and low-pressure steam



Care of Injector Pipes

Check the Valves
The boiler operator should open the hand pull on the safety valve after each heating period to make sure the seat is not sticking. This is done after the injector grid has been disconnected and while there is still steam pressure. Warning: *Before testing, be sure no one will be injured by the escaping steam.*

Float valves and cutoff valves should be operated manually from time to time to check their operation, especially if the low water cutoff valve is used as a safety device.

A chattering noise in the feed water (supply source) tank, or the presence of hot water in the feed water tank, indicates that steam or hot water is backing into the tank during the water-pump "off" period. To correct this, remove and clean the check valve and strainer between the pump and boiler. Be sure there is no pressure on these parts before removing them.

Use Handhole for Cleanout
Many boilers have one or more handholes or washout plugs in the shell of the boiler. Some boilers also have a cleanout opening at the waterline. These are provided to permit periodic inspection and cleaning of the inner surface of the boiler. If scale forms on the tubes and crown sheets of the boiler, treat the feed water with chemicals to correct the condition. Regular inspection followed by proper treatment when necessary may add greatly to the life of the boiler.

The holes in the injector pipes wear larger with use (fig. 24). Large holes are undesirable because they permit more steam to enter the load than the boiler can produce or than the garbage can absorb. Large holes also permit more steam to escape near the inlet pipe than at the end of the pipes, resulting in uneven distribution of steam. When the diameter of a hole has doubled, the size of the opening and the amount of steam that escapes through the hole has increased fourfold.

Some indications of oversized holes are:
1. To maintain pressure, the boiler valve must be throttled more than initially.
2. The garbage at the end of the injector pipes (further from the steam inlet) heats more slowly than that near the inlet.
3. There is excessive bubbling and splattering of garbage immediately above the injector holes (fig. 25), which indicates excess steam release.
4. A longer heating period is required.

A survey indicated that holes wear out first near the header inlet. Holes wear larger and at about the same rate regardless of whether high-pressure or low-pressure steam is used. Also, large holes wear as fast as small holes. For these reasons the initial size of the holes should be small (1/16 inch).

Although the injector pipes of the equipment studied in the survey were used an average of 800 hours before replaced, they should be replaced more often for efficient operation. After being used 800 hours, twice as much steam escaped as through the original holes. One set of pipes was left unchanged for 3,000 hours; by that time, 64 times as much steam escaped as through the original holes.

Figure 24. — Injector holes wear larger with use

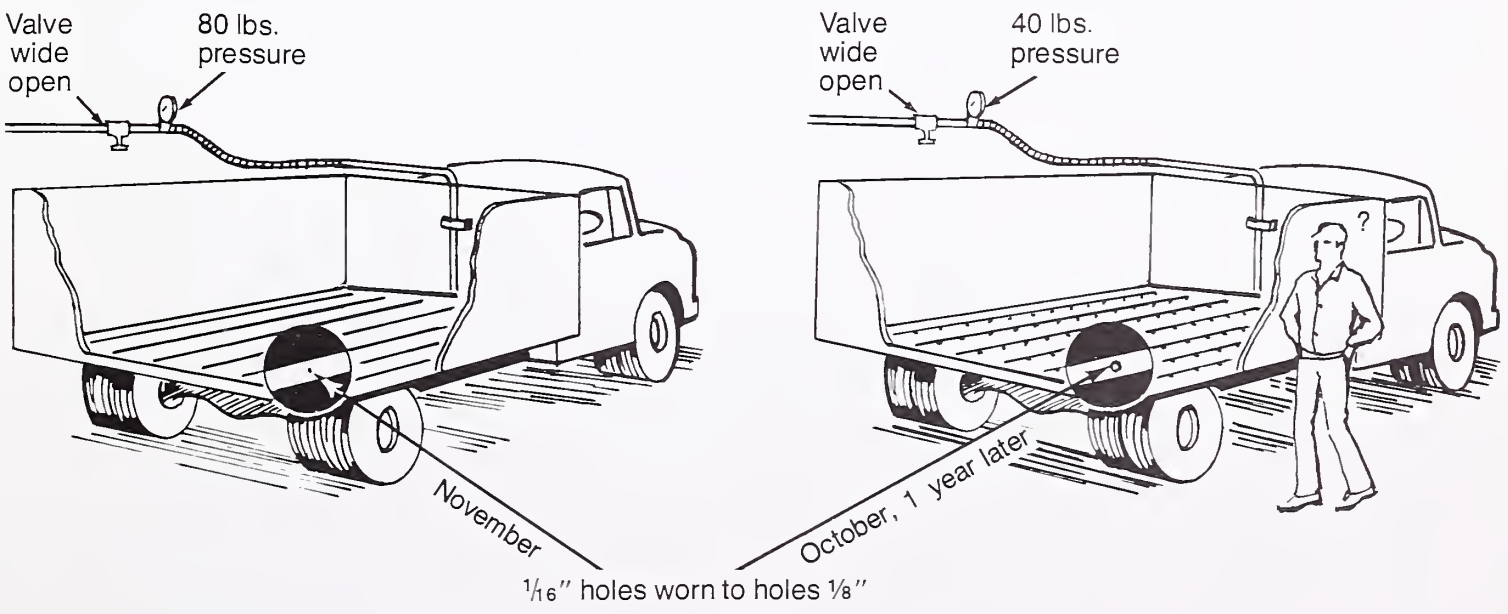
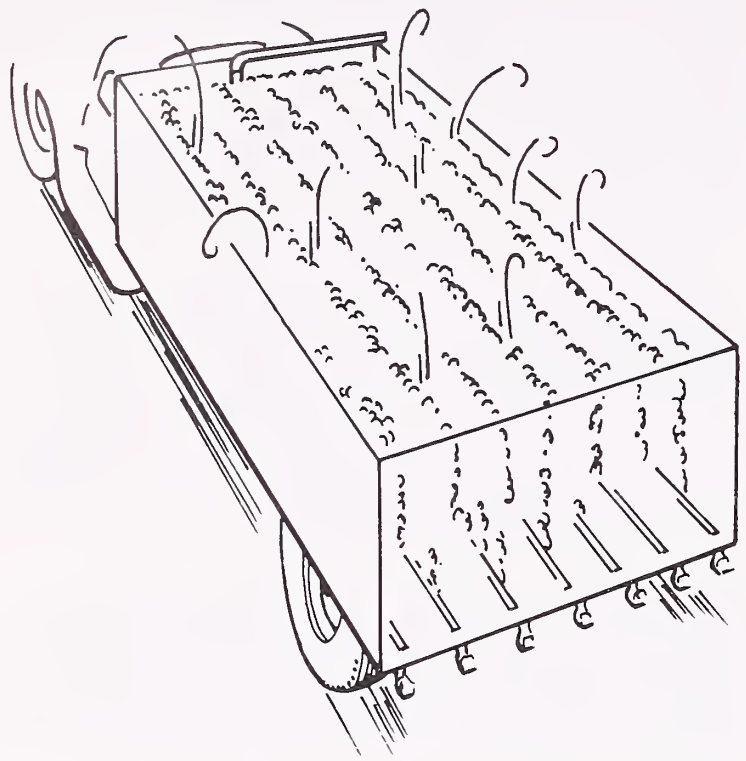


Figure 25. — Garbage splatters above large holes



Therefore, it is recommended that injector pipes be replaced at least once a year. It is more economical to replace these pipes than to pay for the extra fuel and labor required to maintain the proper temperature with such worn equipment.

Cooling Garbage

To hasten cooling, spread garbage in thin layers in the feeding troughs several hours before feeding. In one test cooling garbage in a trough 3 inches deep for half an hour was equivalent to cooling it in a vat overnight for 10 hours. The cooling rate is a function of the shortest distance (which is usually the depth) from the material to the air.

Cooling by adding cold water to the load is unsatisfactory.

Cost of Heat Treatment

The cost of heat-treating garbage depends on the type and condition of the equipment, the skill and efficiency with which the operator uses the equipment, and the outside temperature.

In general, large loads are heat treated more economically than small loads. However, of more importance than the size of the load is a well-designed, efficiently operated system: use of tight-fitting lids, correct boiler size, carefully regulated pressure, and injector holes of the proper size.

Sanitation

Proper heat treatment of garbage is a major factor in the reduction of losses from some infectious diseases, but much of the advantage thus gained is lost unless sanitary feeding methods are used. Sanitary methods of feeding are easier if the piggery is built with this in mind. The following points are essential for good hog-farm sanitation:

1. Garbage or similar hog feed should be fed in troughs made of nonabsorbent material that can be easily cleaned, washed, and disinfected. Troughs at least 14 inches wide and open at the top will permit easy cleaning.
2. The heating operation should be so located and constructed that swine will have no access to the raw garbage.
3. Feeding areas should be hosed down or dry-cleaned daily to remove any accumulation of inedible materials such as bones, trash, and manure.
4. If washwater and urine are disposed of on the ground, they should be drained in such a way as to prevent them from becoming a nuisance or a health hazard.
5. The hog-raising operation should be maintained rodent-free by building ratproof structures, by eliminating rat harborages, by removing or controlling any material that serves as a food source, and by supplemental eradication procedures.
6. The hog-raising operation should be maintained free of flies. This should be achieved basically by good sanitation practices, but insecticides may be used to supplement these practices. These insecticides must be used as directed on the label.
7. Any uncooked garbage that is accidentally spilled outside the feeding area should be disposed of promptly. Such garbage attracts rats and provides a breeding place for flies; also, loose pigs may find this feed and contract disease.

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